CBO Systematic Study Status Report

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Linear vs. Quadratic

- In E821, a linear dependence was assumed between muon phase-space position and detector acceptance
- This project aims to determine if that is the case or if the acceptance has a quadratic term
  - Linear: simple, good
  - Quadratic: messy, bad
    - See doc-db #

$$N_D(t) = k_1 N_e(x_0 + f_{\bar{x}}(t) A_x \cos(\omega t + \phi_x)).$$

$$N_D(t) = N_e[(A_0 x_0^2 + A_1 \sigma_0^2) + B_0 f_x(t)\cos(\omega t + \phi_x) + B_1 f_\sigma(t)\cos(\omega t + \phi_\sigma) + C_0 (f_x(t))^2 \cos(2\omega t + \phi_x) + C_1 (f_\sigma(t))^2 \cos(2\omega t + \phi_\sigma)].$$

E821

Basic physics equation describing the rate of detected positrons:

$$dN/dt = N_0\, e(-t/\gamma\tau_\mu)[1 + A\cos(\omega_a\, t + \varphi)]$$

$$N_0 \rightarrow N_0\,[1 + A_N\, e\text{^}(-t/\tau_{CBO})\, \cos(\omega_{CBO}\, t + \varphi_N\,)]$$

$$A \rightarrow A\,[1 + A_A\, e\text{^}(-t/\tau_{CBO)}\, \cos(\omega_{CBO}\, t + \varphi_A\,)]$$

$$\varphi \rightarrow \varphi + A_\varphi\, e(-t/\tau_{CBO)}\, \cos(\omega_{CBO}\, t + \varphi_\varphi\,)$$

Here I'm covering the acceptance rate as a function of muon x-position at the time of decay.

Assumptions and Muons

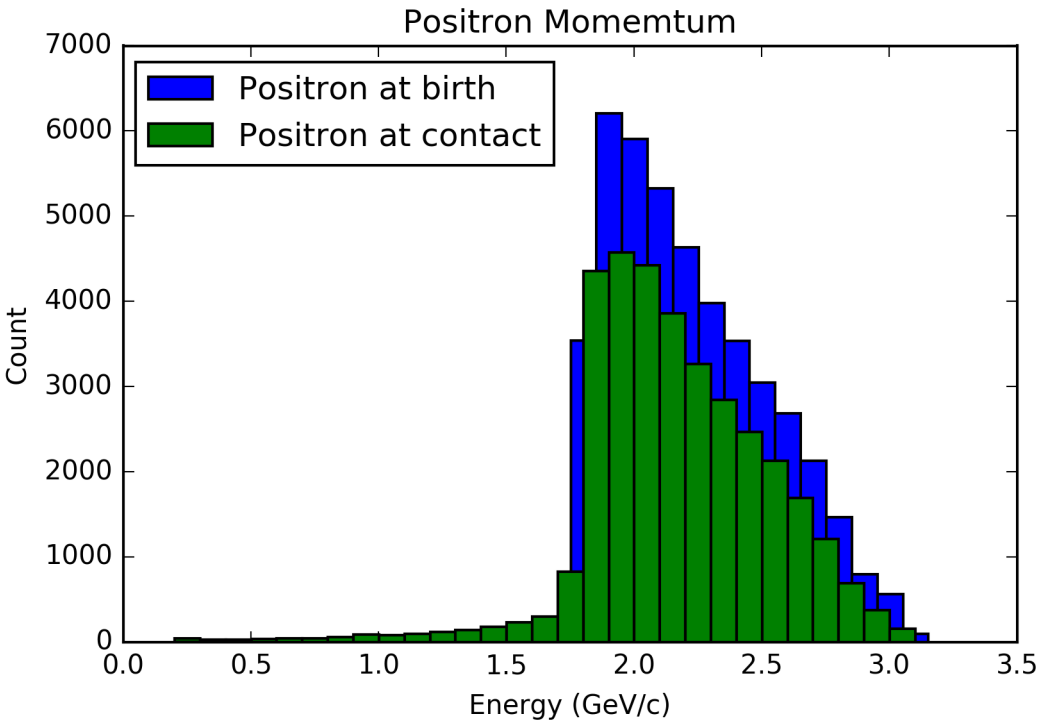
- B-field is constant everywhere
- E-field does not exist outside the electrodes
- Geometry
  - No electrode curls
  - Trolley rail kills positrons/gammas immediately

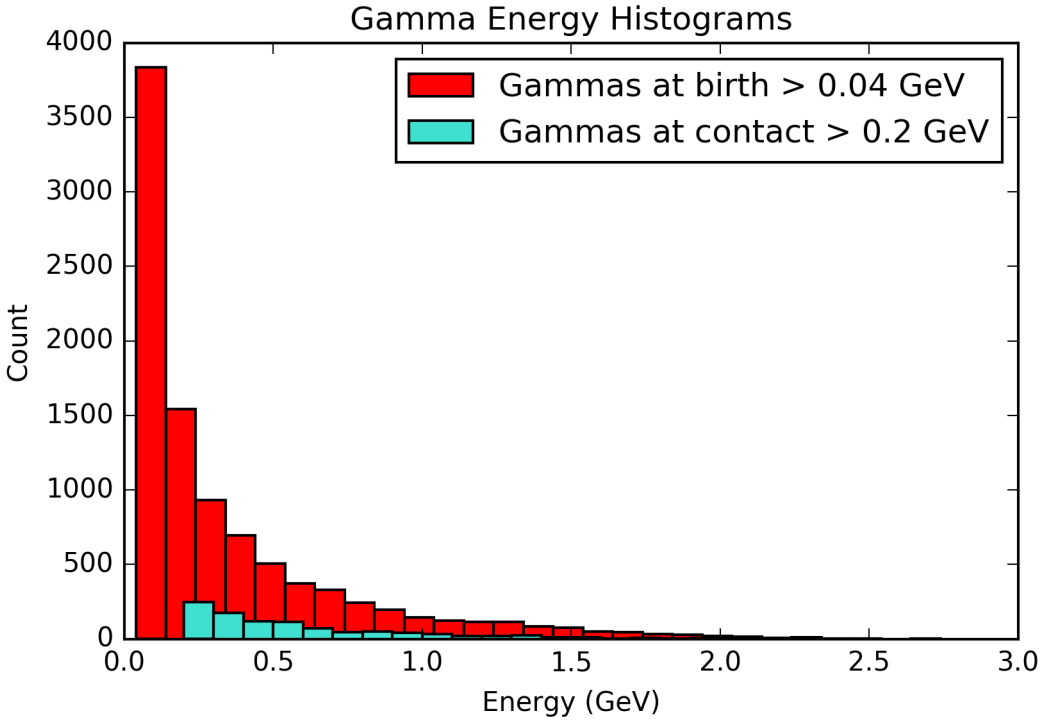
Muon data came from Dave Rubin at Cornell, he provided phase-space data on 5171 muons, 100 microseconds after injection.

To get more than 5171 positrons, this set of muons was used multiple times, allowed by the randomness in the decay process itself.

Energy and Momentum

Gammas with energy < 0.2 GeV were not tracked due to time.

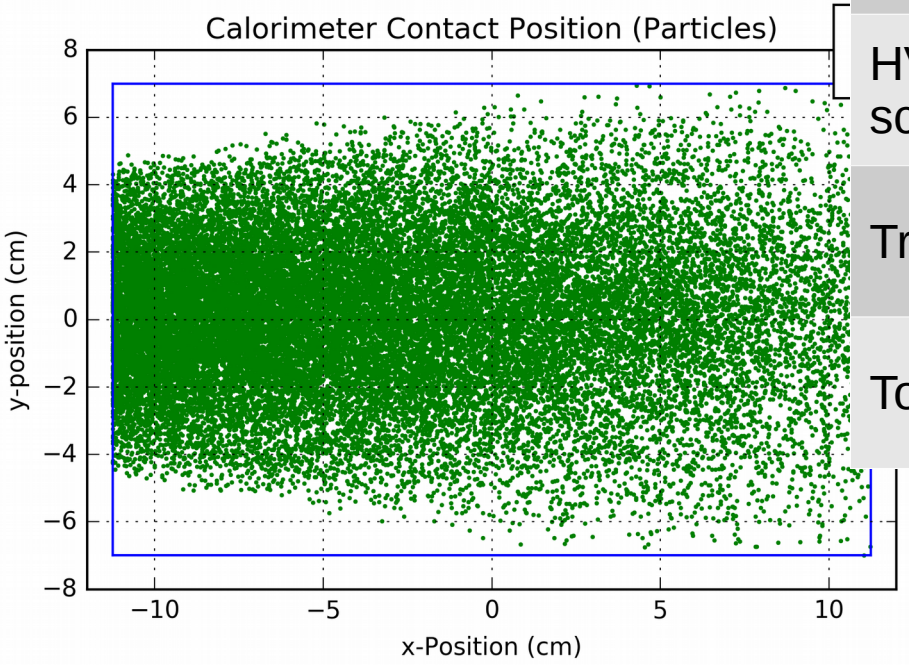




Positron Data

Positrons tracked: 44310
Calorimeter side hits:
3363 (~7%)
Calorimeter front hits:
30965 (~70%)
Total Calorimeter Hits:
34328 (~77%)

	Positron Contact (%)*	Gammas Created (%)
Electrode	15936 (36%)	5999 (63%)
Cage plate	3671 (8%)	2290 (24%)
HV standoff	2048 (5%)	868 (9%)
HV Standoff screw	471 (1%)	353 (4%)
Trolley rail	1293 (3%)	N/A
Total	23419 (53%)	9510

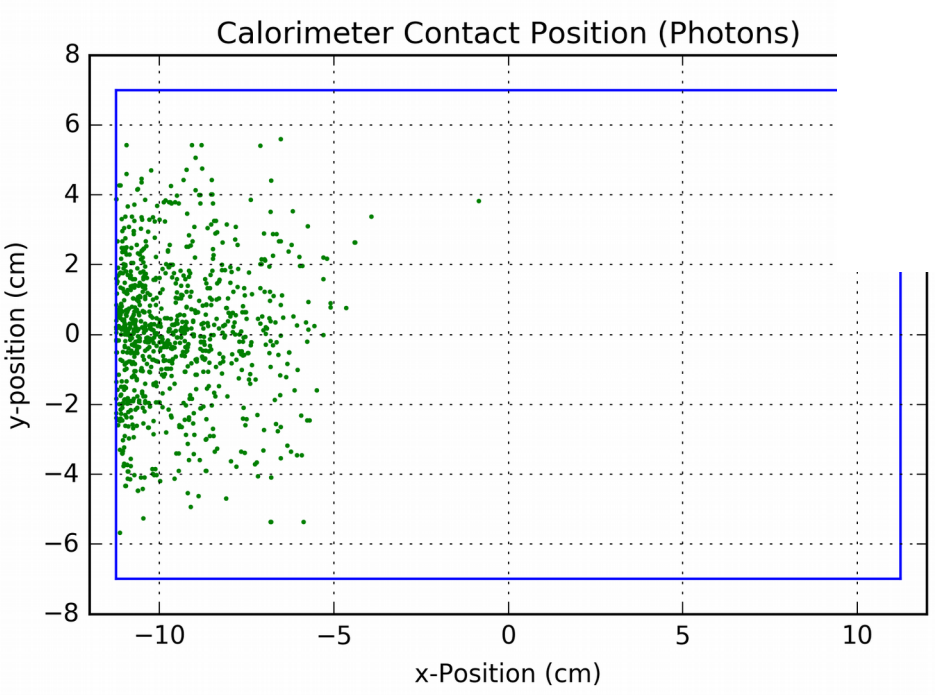


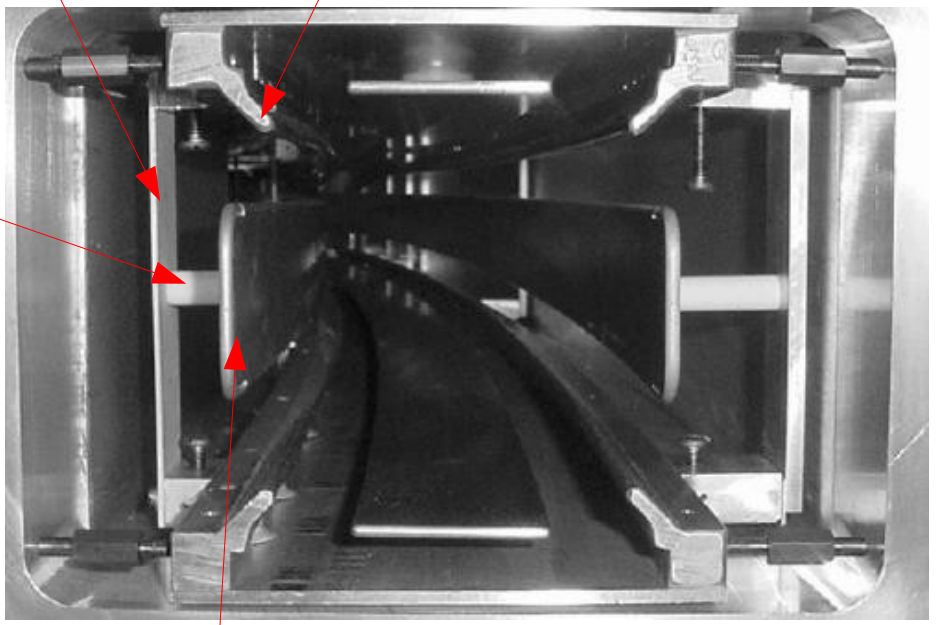
* % of total positrons tracked)

Key: Electrodes dominate contact

Gamma Data

Gammas created: 9510
Calorimeter contacts: 998

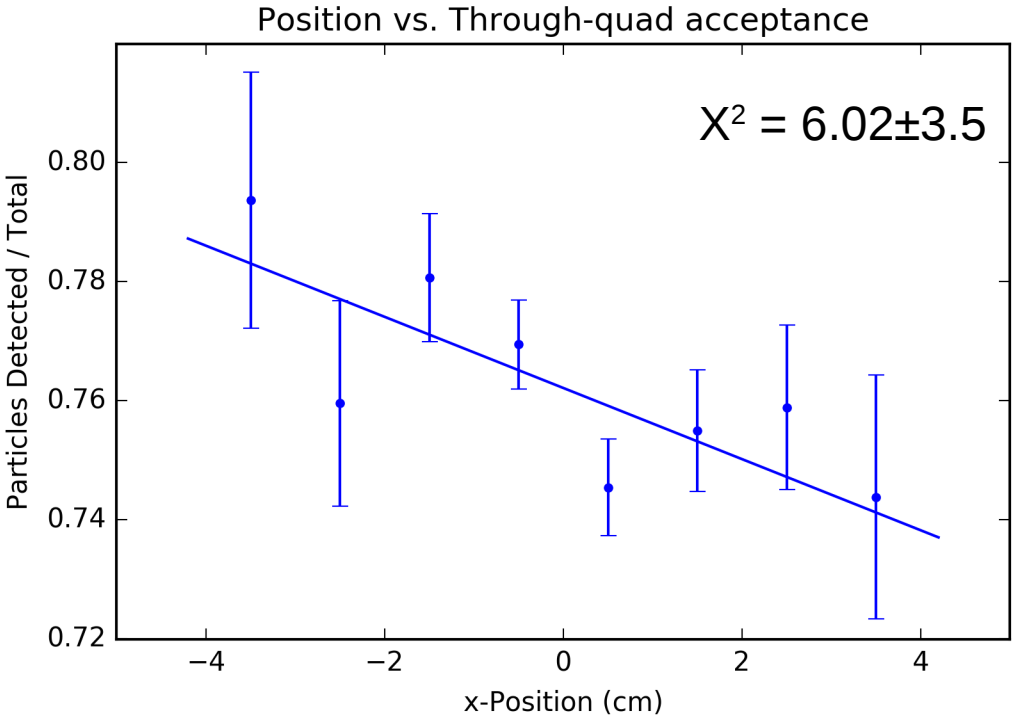


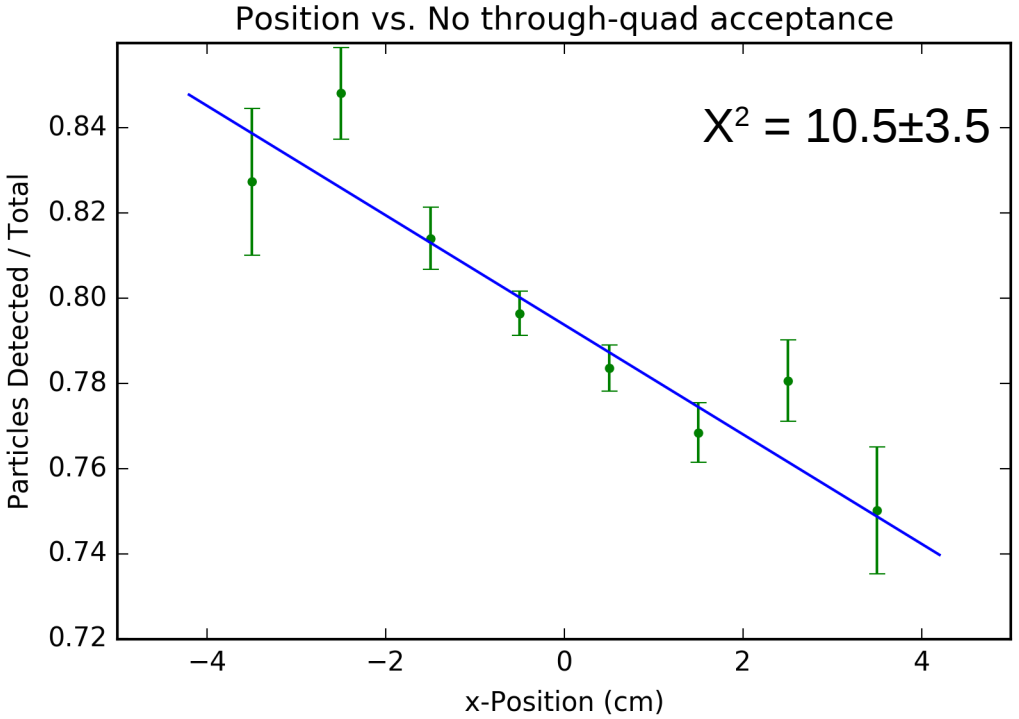


* HV standoff screws are inside the HV standoff

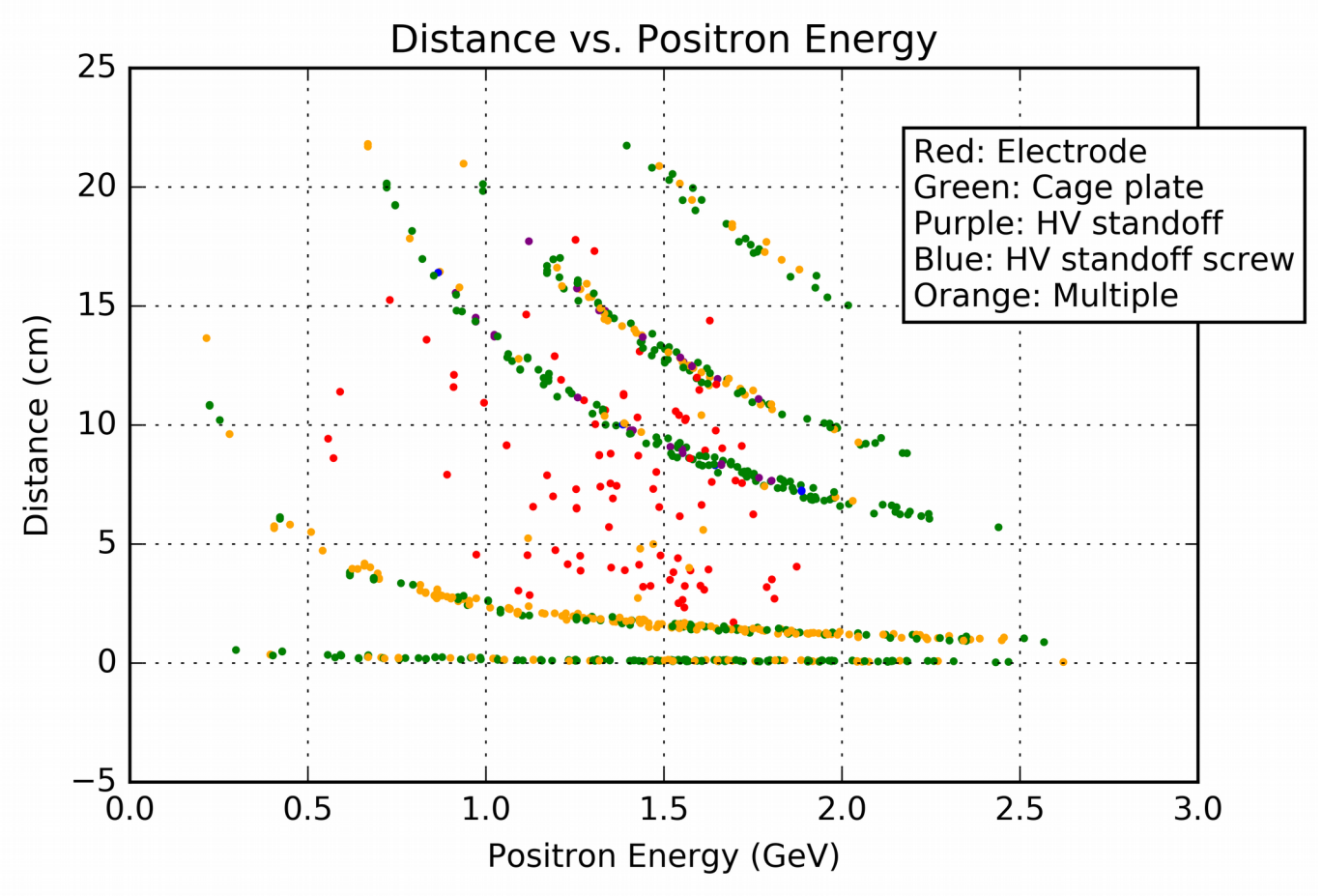
Linear or Quadratic

Currently, dependencies are consistent with linear.





Separation on Calorimeter by Positron Energy at Contact



Positrons that passed through the *only* the stated element, except for orange.

<u>Take-away</u>

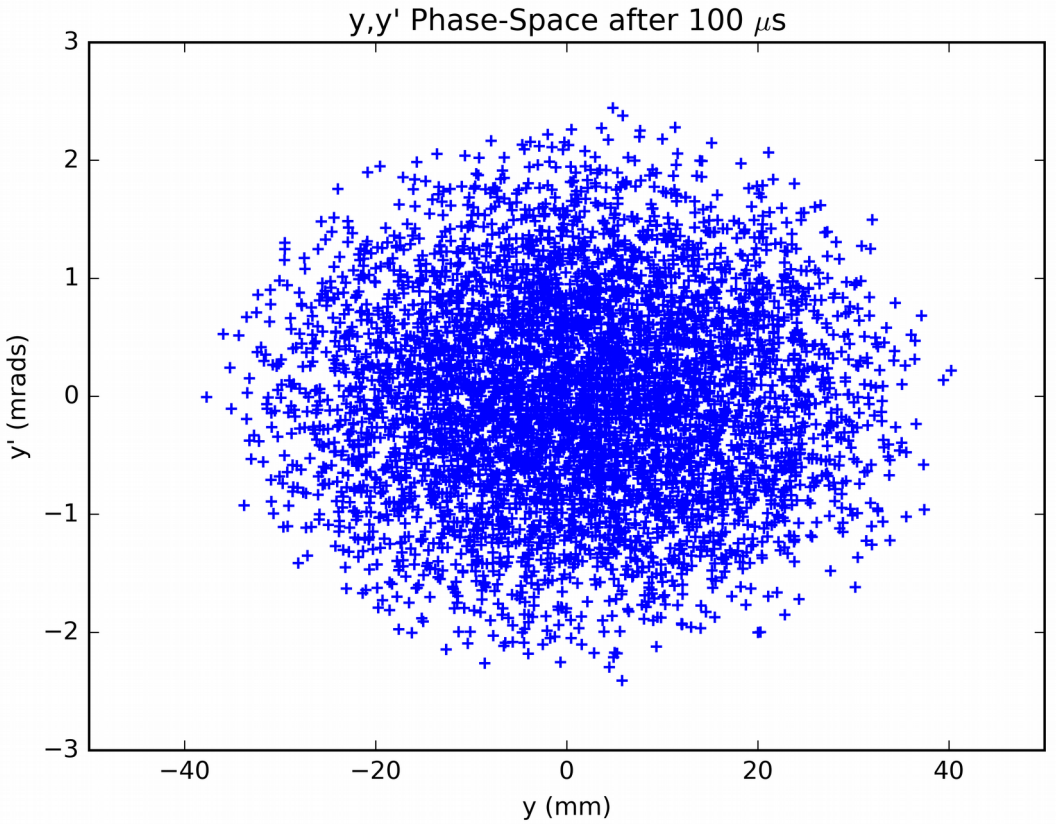
The majority of gamma/positron pairs that contact the calorimeter front come from the cage plates.

Future Work

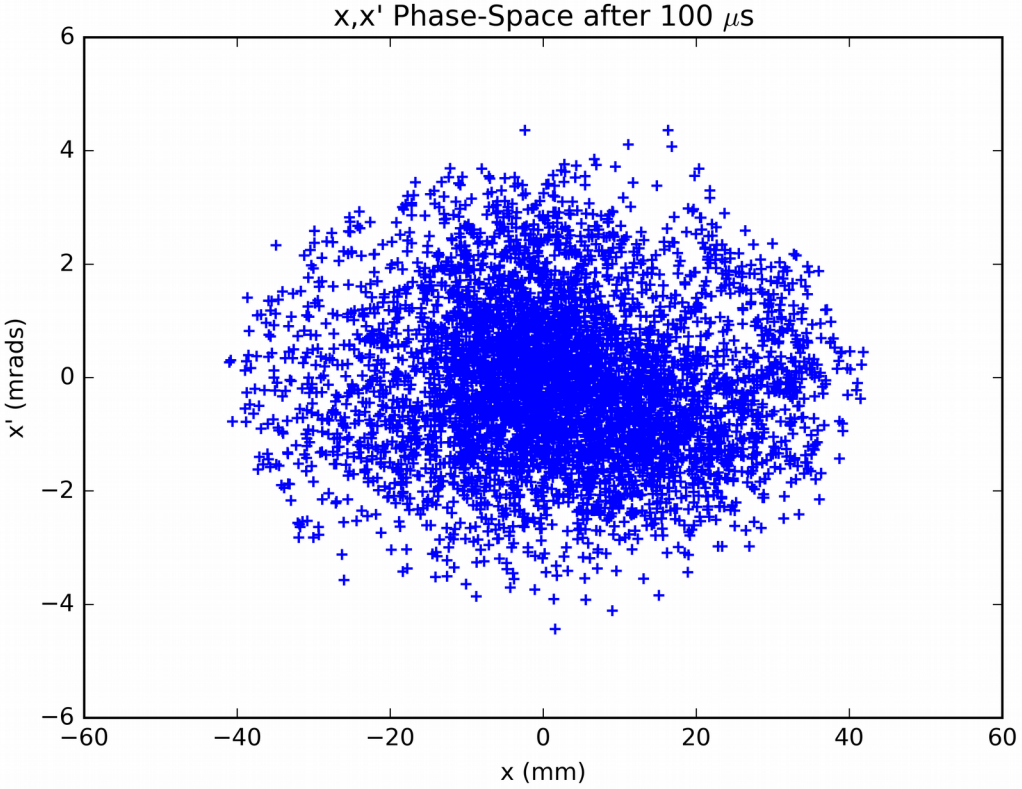
- Remove assumptions
- Find the dependence on x-prime, y, y-prime, and possibly spin
- Study the asymmetry A and phase-offset φ from the equations in slide 3

Extras

Muon Phase-Space

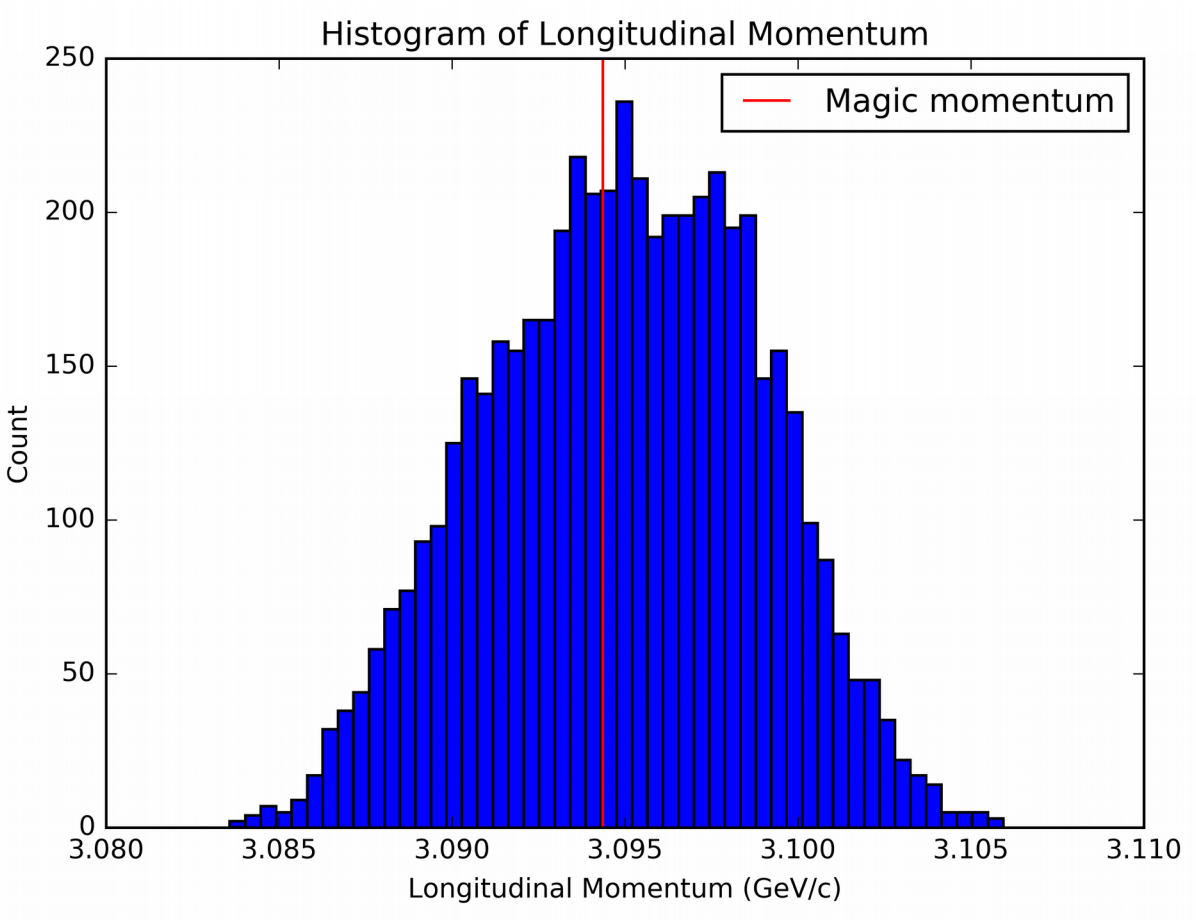


y' = transverse momentum / longitudinal momentum.

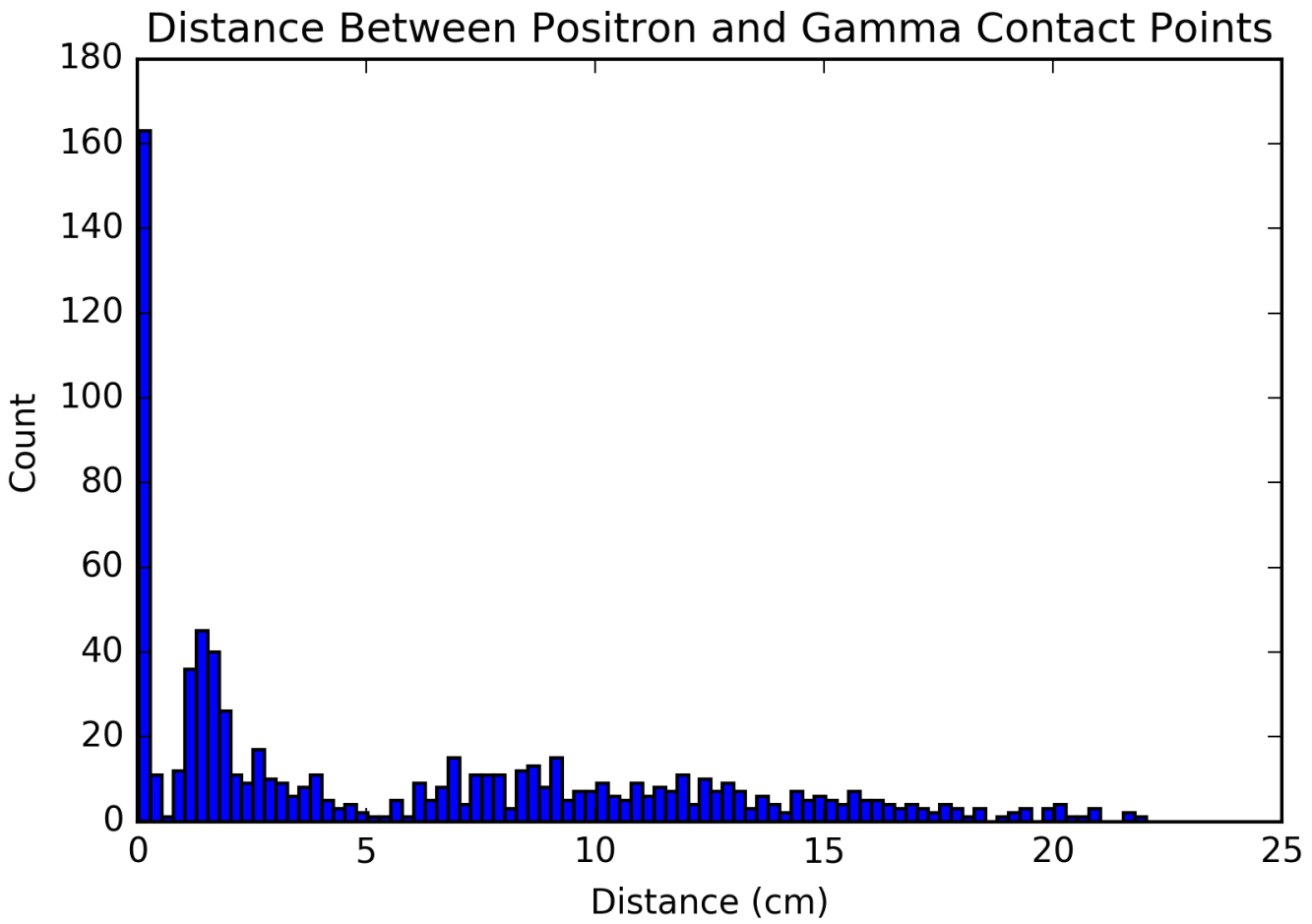


x' = transverse momentum / longitudinal momentum.

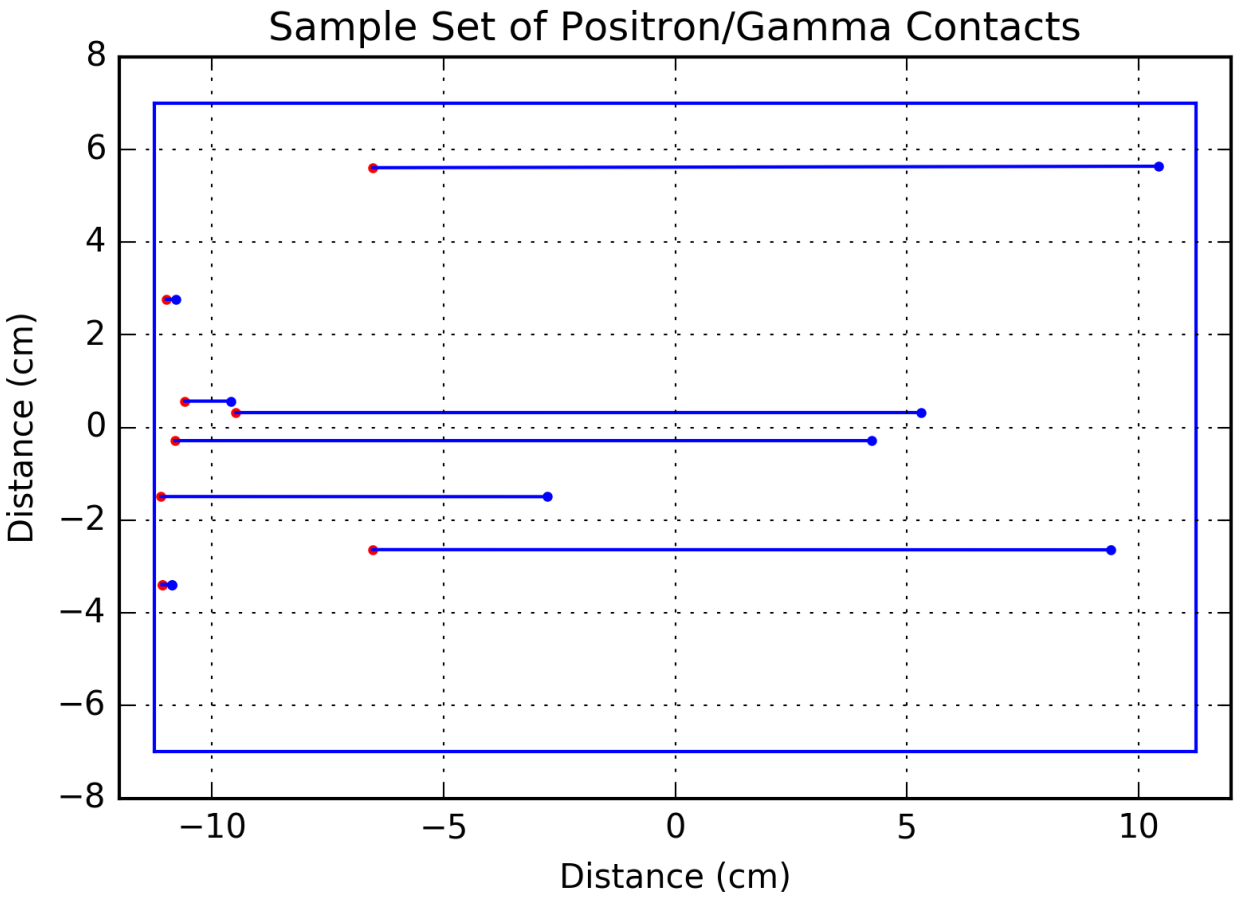
Muon Phase-Space (cont'd)



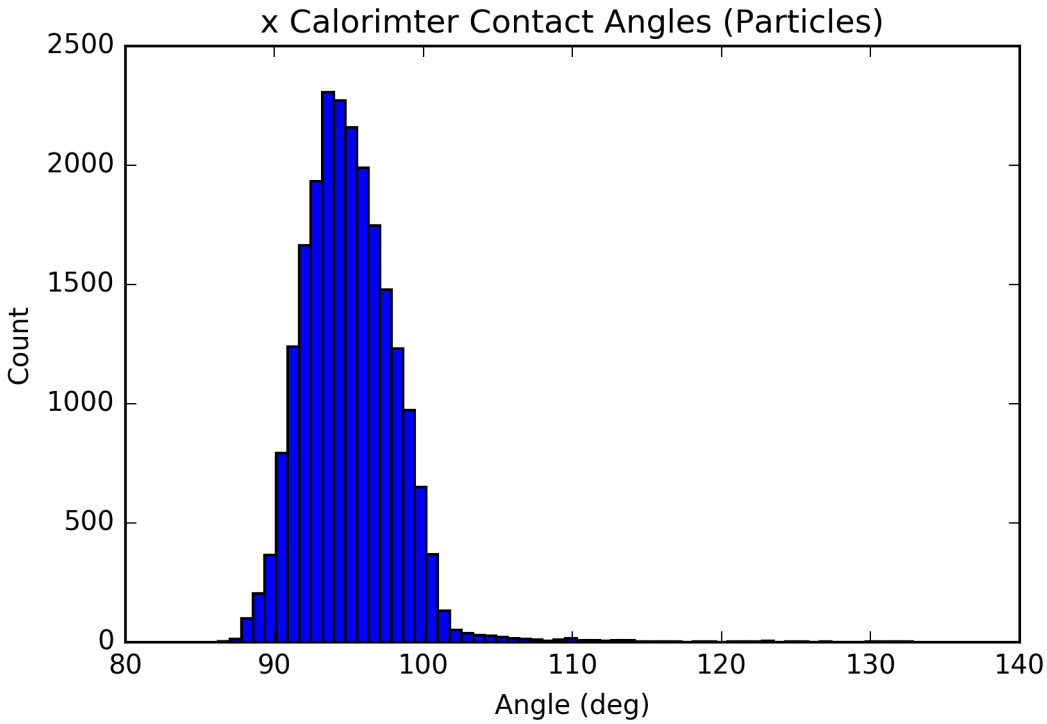
Distance Histogram

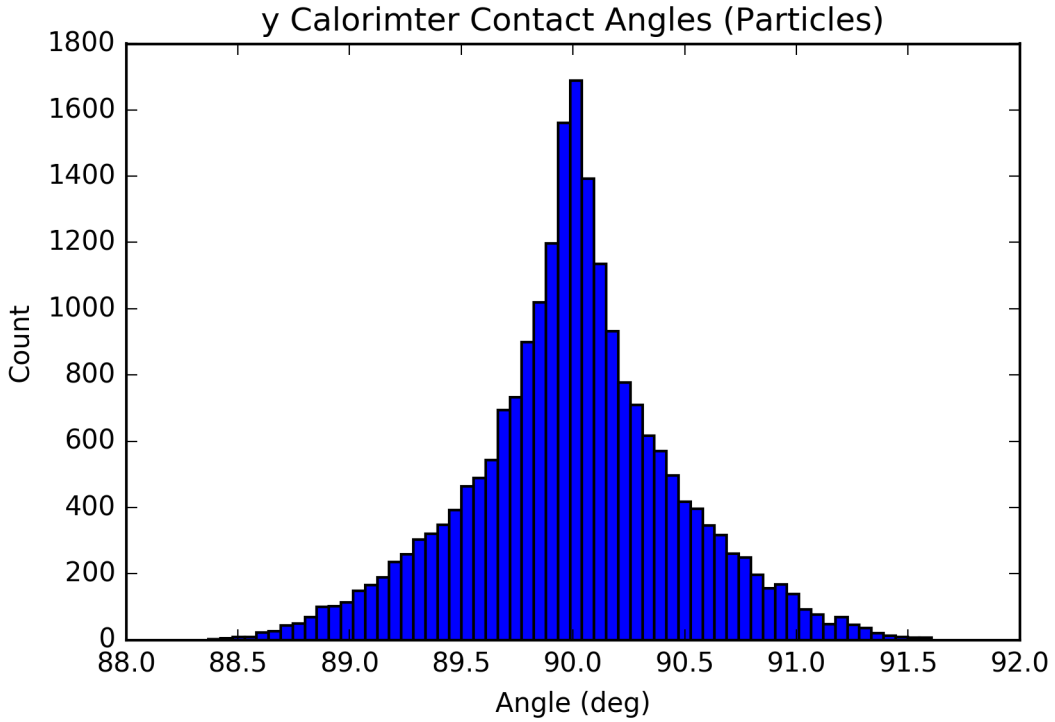


Separation on Calorimeter

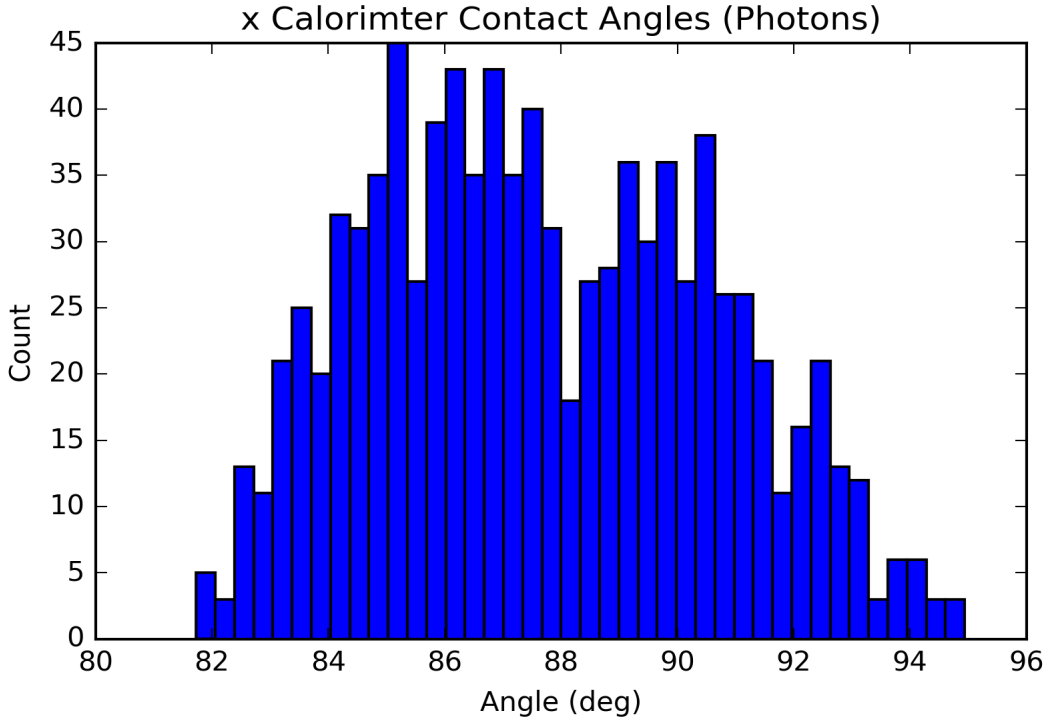


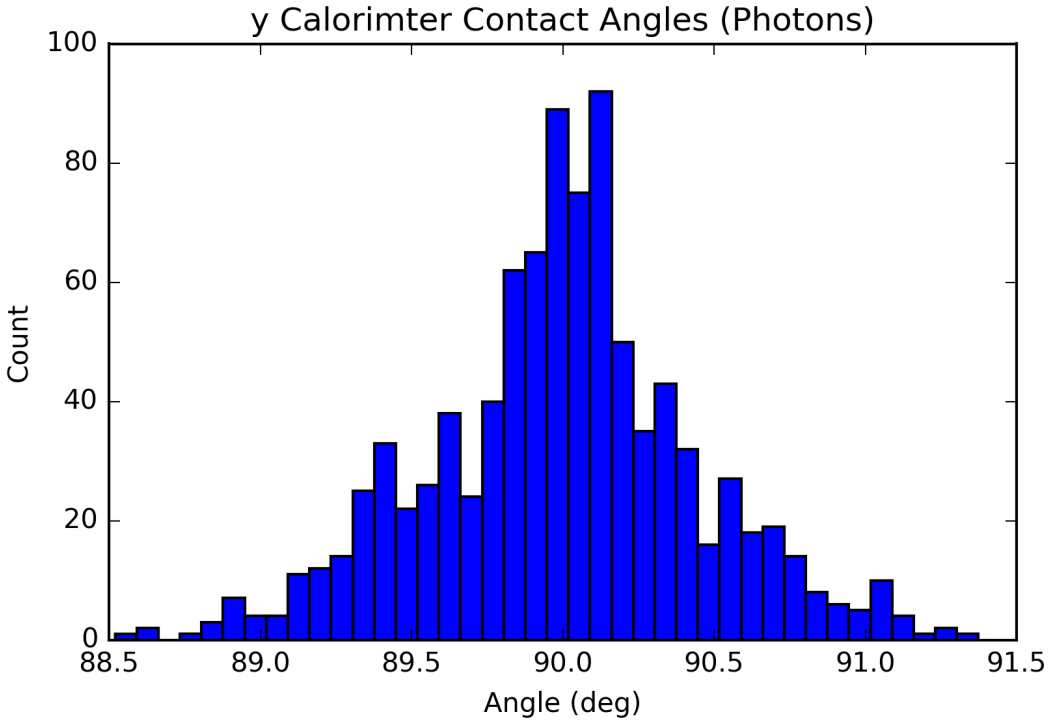
Angles (Particles)



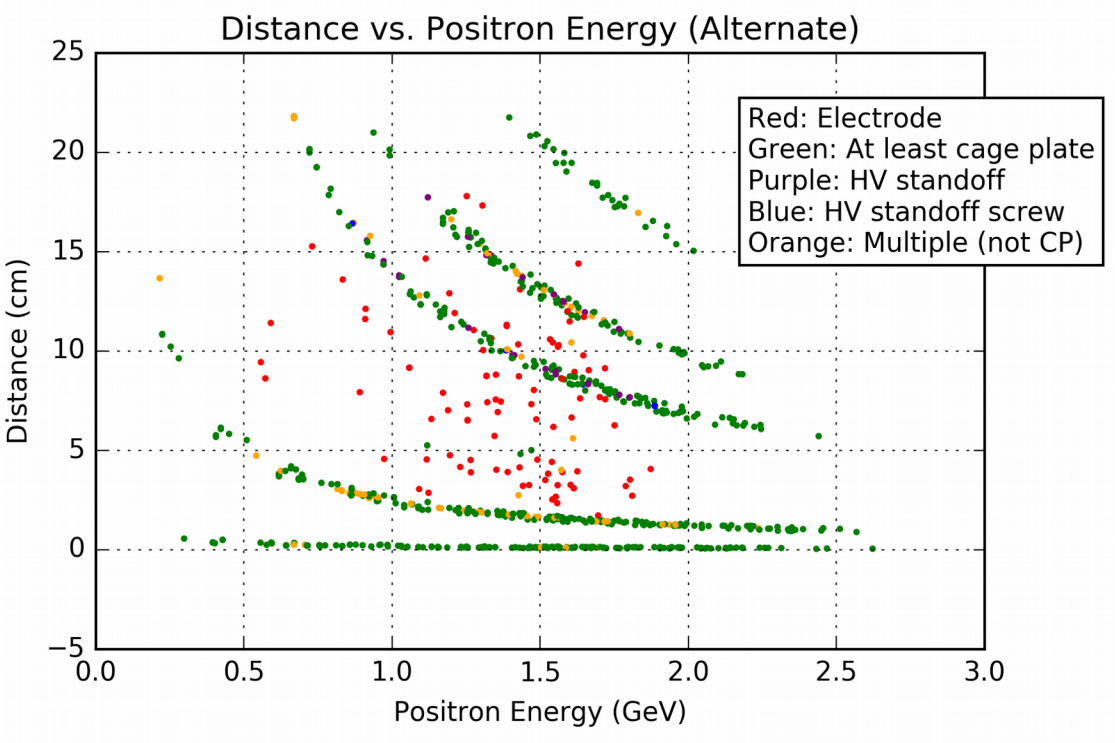


Angles (Gammas)





Distance vs. Gamma Energy



Colors will not necessarily match with ‘Distance vs. Positron Energy’ as the positron colors depend on if the positron passed through an element, not where the gamma was created, whereas here, the color is based on where the gamma was created.

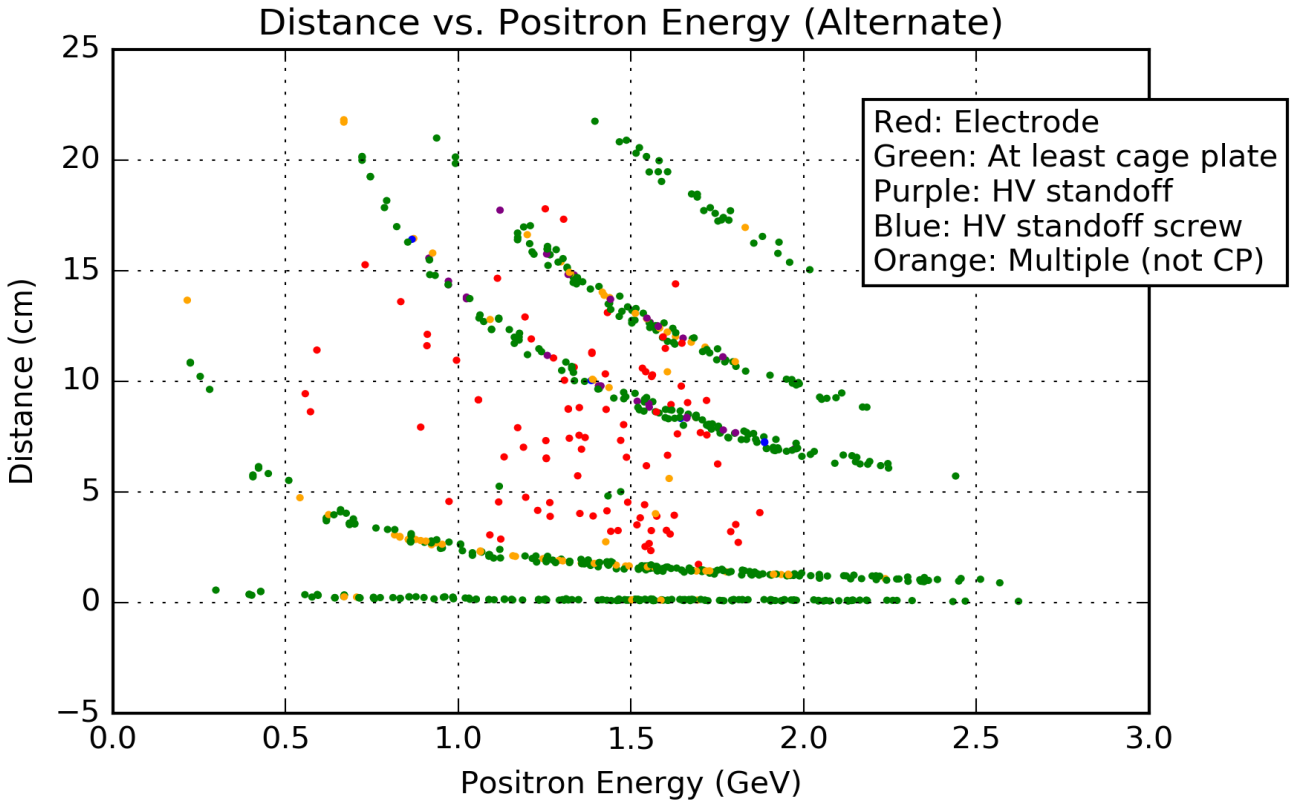
Gamma Data

	Pair-Production Events (% / %)*
Electrode	290 (69% / 3%)
Cage plate	80 (19% / 0.8%)
HV standoff	34 (8% / 0.4%)
HV standoff screw	18 (4% / 0.2%)
Total	422 (4.4%)

Total # of trolley rail contacts: 52

* Percents are:
(% of total events / % of total tracked)

Separation on Calorimeter by Positron Energy at Contact



Green represents positrons that passed through at least a cage plate, possibly other elements as well.